Latitudinal Profiles of Selected Trace Gases

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INTRODUCTION

Atmospheric trace gas concentrations are important as both signals and agents for change during the coming decades. These changes include perturbation of the stratospheric ozone layer by chlorine atoms released in the upper atmosphere from the destruction of organochlorine compounds; exacerbation of the greenhouse effect long attributed to increasing concentrations of CO_2, and now known to involve important contributions from additional trace gases; and variations in the oxidative capacity of the global atmosphere through HO radical perturbations.

The source strengths of CFC gases such as CCl_3F (CFC-11), CCl_2F_2 (CFC-12) and CCl_2FCClF_2 (CFC-113) are known well enough to establish that the atmospheric lifetime of each exceeds 50 years, and that tropospheric losses other than diffusion to the stratosphere are of negligible importance. With negligible loss to tropospheric sinks, both CCl_3F and CCl_2F_2 serve as essentially inert tracers and have been used as calibration gases for atmospheric transport on a global scale in models ranging in sophistication from very simple one-box models to full-scale 3-D transport models.

Tropospheric HO is produced by the reaction of H_2O with $O(^1D)$ atoms released by solar ultraviolet photolysis of ozone. Atmospheric chemistry models clearly show that HO removal of hydrocarbons and hydro-halocarbons is much faster in the tropics than in polar regions. It is also more rapid during summer than winter in temperate zones.

METHOD

This research group has been monitoring the tropospheric concentrations of several halocarbons since November 1977 [*Tyler*, 1983; *Gilpin*, 1990; *Wang*, 1993] and of methane beginning early in 1978 [*Blake and Rowland*, 1988]. Since the mid 1980s measurements of carbon monoxide and numerous nonmethane hydrocarbons (NMHCs) have been added to our routine analysis [*Blake and Rowland*, 1986; *Hurst*, 1990]. Quarterly collections centered around the beginning of each season occur at approximately 40 remote land sites distributed throughout the Pacific region in the latitude range between 71°N and 47°S. The CMDL stations at Barrow, Alaska, and American Samoa are part of the sampling network. Gas chromatography utilizing either flame ionization or electron capture detection are the methods used for all sample analysis. Samples exhibiting numerous large, unidentified peaks may undergo further analysis using GC-MS detection.

RESULTS

Our CFC measurements have been useful in providing data to follow the temporal changes in the global mixing ratios and interhemispheric gradients of these important gases during periods when their production and emissions are changing [*Wang*, 1993]. Other halocarbons routinely assayed provide data critical for estimating their source and sink strengths.

To date, relatively little information has been obtained from actual atmospheric measurements of tropospheric trace gases to show the seasonal and latitudinal variations in their source and sink strengths. However, our measurements of the seasonal variations in tropospheric C_2H_6 concentrations do demonstrate a decrease by a factor of 3 from winter to summer in the northern hemisphere and by a factor of 2 in the southern hemisphere, together with a strong preference for emission in the northern hemisphere [*Blake and Rowland*, 1986]. These results are in reasonable agreement with various measurements and 3-D atmospheric models [*Rudolph et. al.*, 1989; *Kanakidou et al.*, 1991; *Penkett et. al.*, 1993].

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